

## Note on Vertical Test Results of Cavity TE1ACC003

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Cavity TE1ACC003 is a single-cell Tesla-shape cavity manufactured by ACCEL. The cavity had never been processed or tested before arrival at FNAL. The cavity was optically inspected (interior) after arrival at FNAL, and then transported to ANL where it underwent EP, HPR, assembly, evacuation, and leak check using the latest procedures. It also underwent the standard 48hour 120° C bakeout cycle at the FNAL A0 facility. It was then tested at IB1, and it reached a maximum gradient of 42 MV/m. The cavity was then used for mold replica studies, and re-rinsed. Subsequent testing showed the cavity reached 36.6 MV/m (the difference primarily attributable to a refined value for the shunt impedance per unit length, from Superfish simulations), validating the replica mold technique.

This cavity was then used to explore the possibility of defect repair using in-situ laser re-melting. Afterwards, it was re-rinsed and assembled, in part as an effort to ensure that the replacement of the HPR system manifold at the ANL facility had not contaminated the water system or impacted the water quality. It was then transported back to FNAL, to the VCTF at IB1, where it was mounted on the test stand, connected to the pumping system, and instrumented with a single band of Cernox sensors from the Fast Thermometry System (FTS), and installed it he VTS-1 Dewar in preparation for test..

The cavity was cooled down to 2.00K so that CW measurements of  $Q_0$  vs E could be performed. The cavity's field probe was calibrated at field levels of about 3.7MV/m, and yielded a value of  $2.81 \pm 0.05 \times 10^{12}$  ( $Q_2$ ). The decay measurements ( $\tau$ ) used to calculate  $Q_2$  were within 1.1% of each other, and the calculated values of  $Q_2$  were consistent to within 2.62%. The input coupling was determined to be  $6.21 \times 10^9$  ( $Q_1$ ), and the cavity remained overcoupled throughout the test.

Low field  $Q_0$  was found to be about  $1.8 - 1.9 \times 10^{10}$  at gradients between 3-5 MV/m, and decreased gradually as field increased. The cavity reached a gradient of 26.3 MV/m, limited by a hard quench. The  $Q_0$  at this quench limit was  $8.0 \times 10^9$  (see Figure 1). There was no indication of radiation above background, so the cavity performance was essentially FE-free. At this maximum field,  $P_{\text{input}}$  was ~11.22.W, with  $P_{\text{loss}}$  about 10.98W, with the cavity near critically-coupled ( $P_{\text{ref}}$  was ~0.21W).

Scans performed with the FTS at 2.00K with the cavity operating at the quench field indicated significant heating on one of the sensors, RTD #4 (See Figure 2). No pre-quench heating was observed. In an attempt to better localize the quench origin, the bath temperature was raised so that the effects of superfluid He cooling would be decreased/eliminated, leading to stronger signals from other nearby sensors. The effects of this can be seen in Figures 3 and 4. In Figure 3 we see that at 2.18K, the cavity quench leads to measurable temperature increases not only on RTD #4, but also on the sensors that are nearest-neighbors to RTD #4 (RTD#3 and RTD#5). Note that the second set of

temperature spikes in Figure 3 appear to show evidence that the quench origin is changing – while RTD #4 still shows the largest temperature rise, RTD#5 shows the second highest temperature rise, whereas RTD #3 showed the second-highest temperature rise in the earlier quench shown. Additional evidence for this can be seen in Figure 4, which shows many quenches at 2.18K, with the primary heating site alternating between RTD #4 and RTD #5.

It was also noted that at higher temperatures (slightly above  $\lambda$ ), the cavity was found to quench at slightly higher gradients than at 2.00K – about 27.6 MV/m, as opposed to 26.3 MV/m (see Figure5). Since there was no FE observed at any time during this test, this represents a real change in quench field, and not the result of field emitter processing.

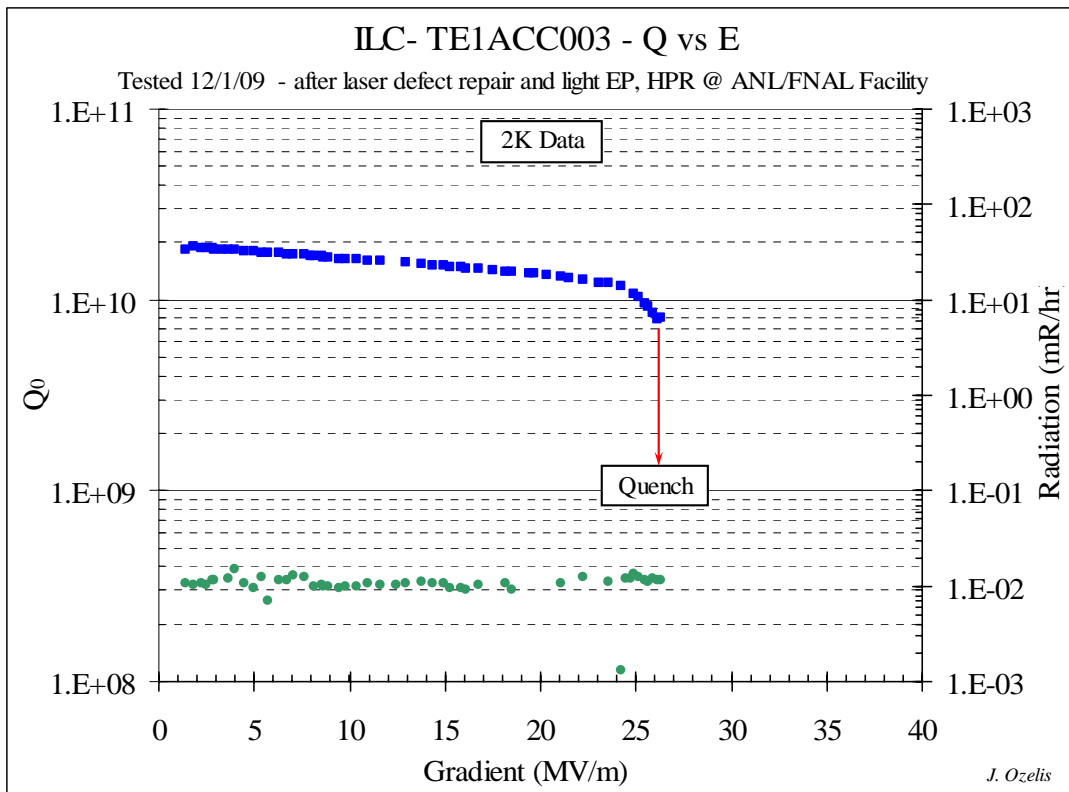


Figure 1.) Q<sub>0</sub> vs E run at 2K

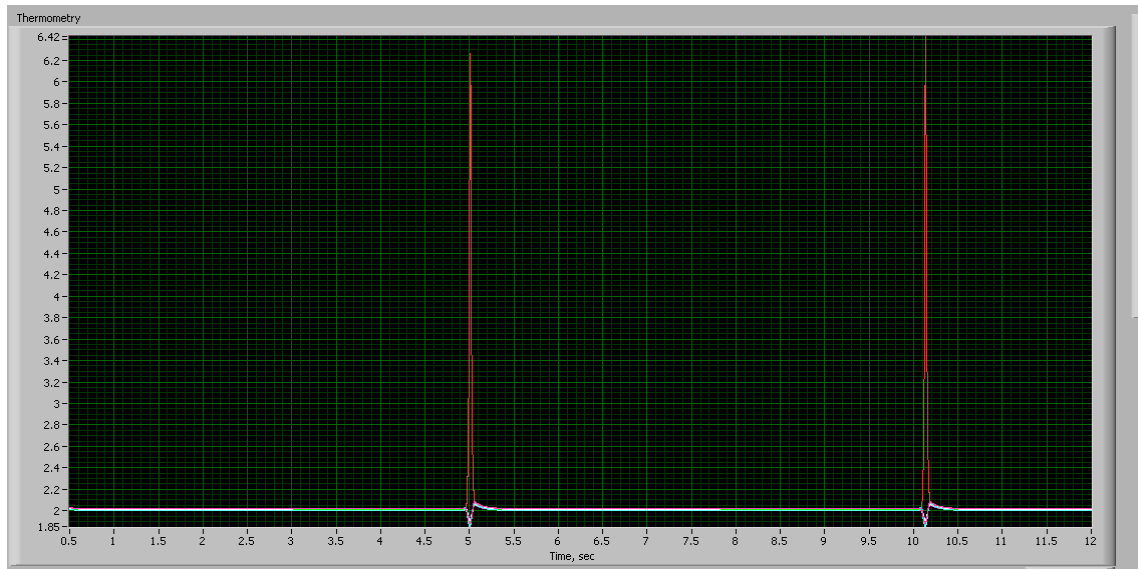


Figure 2.) Response of thermometers during quench at 2.00K. RTD #4 (red) shows the only response, and no pre-quench heating is evident.

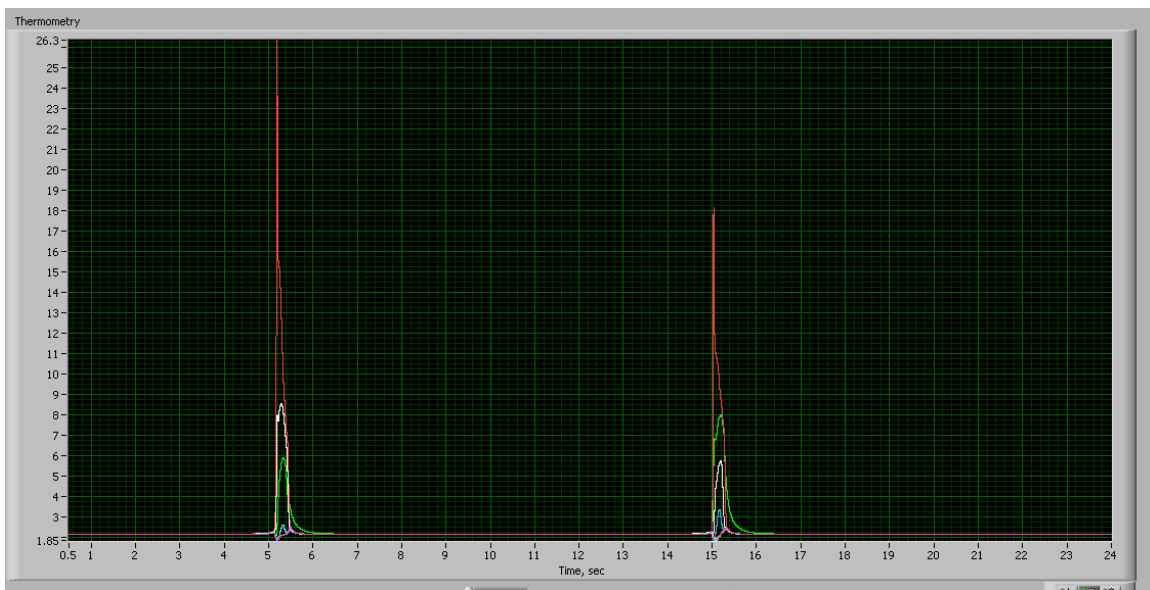


Figure 4.) Response of thermometers during quench just above  $\lambda$ -point (2.18K). Now there are measurable temperature rises in RTD's #3 (white) and 5 (green), in addition to RTD #4. Note that in the second quench shown, RTD #5 shows the second highest response, whereas previously it had been RTD#3.

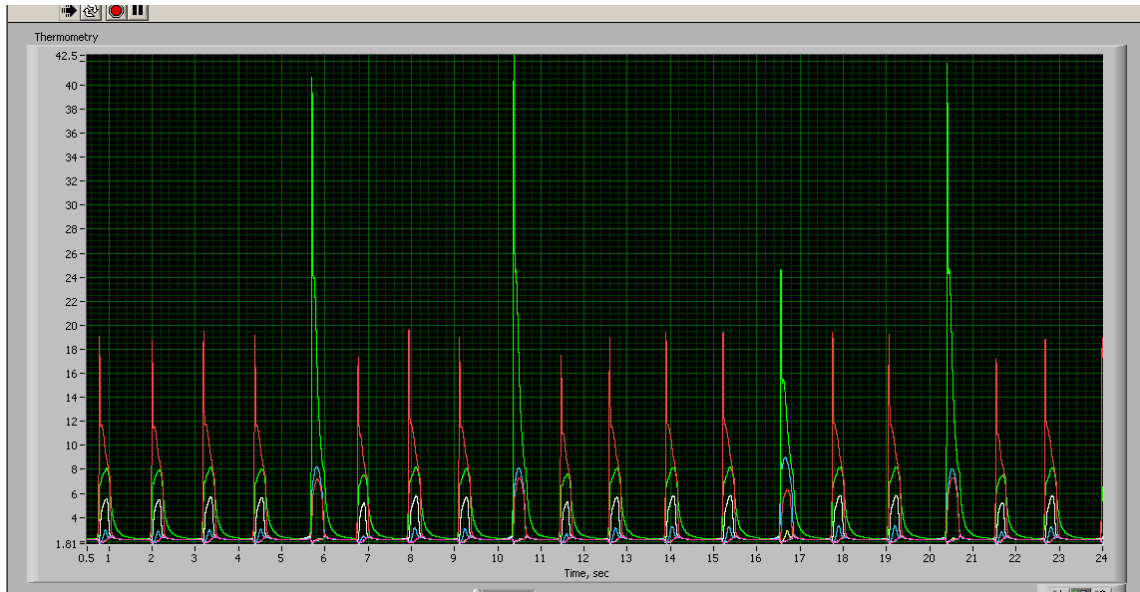


Figure 4.) Response of thermometers during quench at 2.18K, showing the primary quench origin shifting location along the equator, (as noted by the highest temperature spikes alternating between RTD #4 (red) and RTD #5 (green)).

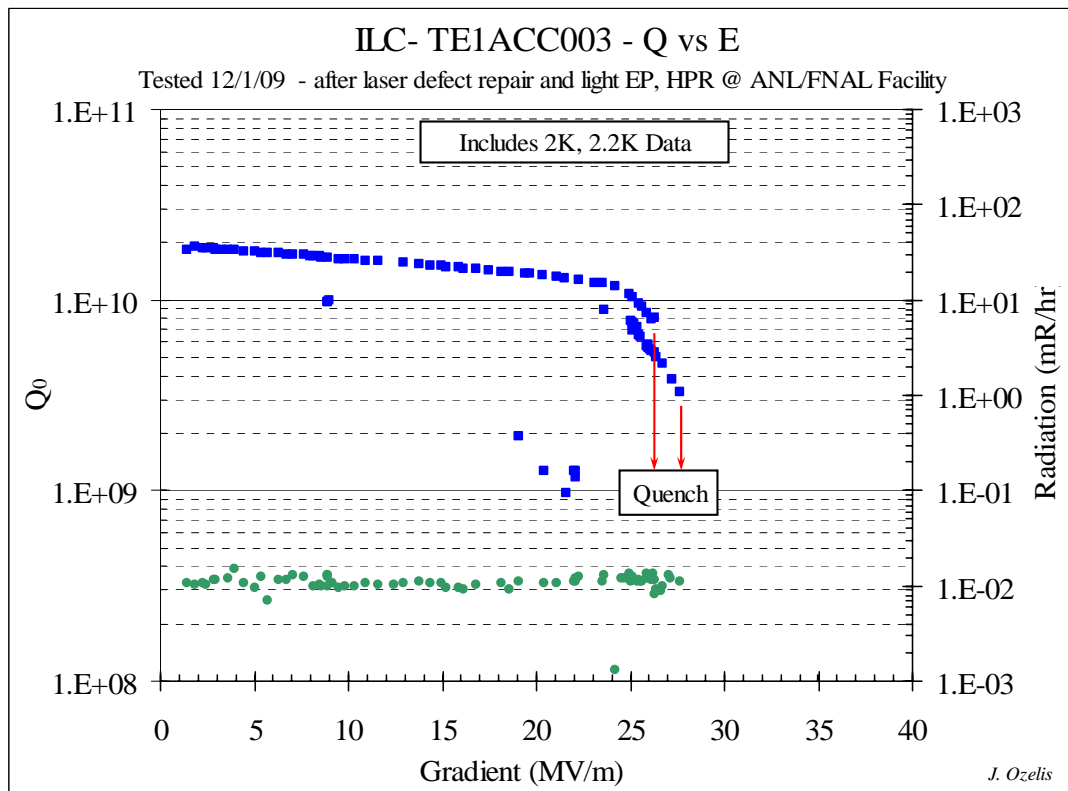


Figure 5.) Effects of raising temperature above  $\lambda$ -point. As the  $Q_0$  is reduced due to the higher temperature, the quench limit increases somewhat to  $>27$  MV/m.